**Narrative Final Report**
**NCPTT 2011 Grants**
**Grant Number: MT-2210-11-NC-05, Philadelphia Museum of Art**

## TITLE PAGE

**Grant Number:** MT-2210-11-NC-05

**Project Title:** Raman Spectroscopy Workshop and Database Training for the Preservation Community

**Organizational Name:** Philadelphia Museum of Art (PMA)

**Principal Investigator:** Beth Price

**Project Team:**
Beth Price, Senior Scientist (PMA), Principal Investigator, Workshop Planner, Trainer
Andrew Lins, Conservation Department Chair (PMA), Workshop Planner, Trainer
Chris Wasson, Conservation Department Administrator (PMA), Workshop Planner
Ken Sutherland, Conservation Scientist (PMA), Workshop Trainer
Gabriel Richards, CEO and Developer (Endertech Inc.), Presenter, Workshop Instructor
Charles Davis, IT Architect Specialist (The Dow Chemical Company), Workshop Trainer
Suzanne Lomax, Organic Chemist (National Gallery of Art), Presenter, Workshop Trainer

**Contact:**
Beth Price, Senior Scientist
1 215 684-7552, bprice@philamuseum.org

Andrew Lins, Conservation Department Chair
1 215 685- 7545, alins@philamuseum.org

Chris Wasson, Conservation Department Administrator
1 215 685- 7542, cwasson@philamuseum.org

Kara LaFleur, PMA Grants Manager
1 215 684-7754, kara.lafleur@philamuseum.org

**Date of Report:** 31 December 2012

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**NCPTT 2011 Grants**
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**Philadelphia Museum of Art**

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## 1. EXECUTIVE SUMMARY

Raman spectroscopy is recognized within the preservation community as a potentially powerful technique for analysis of cultural heritage objects. The use of Raman to aid in the preservation and study of these objects has grown dramatically in recent years. Most major museums own or plan to purchase an instrument, especially for identifying pigments, minerals and corrosion products. However, greater use of Raman has been limited by the lack of training to overcome challenges that are particular to cultural heritage analysis and a lack of suitable reference spectra.

To address the need for information and training, the National Center for Preservation Technology and Training (NCPTT) awarded an $12,000 grant to the Philadelphia Museum of Art (PMA) to support a Raman spectroscopy training workshop for the preservation community. The resulting three day workshop was held at the PMA on September 27-29, 2012. During the first two days, instructive lectures (open to the general public) were given by sixteen experts on a range of Raman topics that included theory, instrumentation and cultural heritage applications.

The lectures were attended by 102 participants (maximum workshop capacity) representing a cross-section of scientists, conservators, students, and educators. The learning opportunity was extended via a live stream viewed 1320 times in North and South America, Europe and Africa. The webcast will be placed on the Infrared and Raman Users Group (IRUG) website (www.irug.org) for additional outreach.

On Day 3, interactive training was conducted on how to discriminate quality Raman data and utilize the new IRUG Raman spectral database. The web-based database, which was developed under an Institute of Museum and Library Services (IMLS) National Leadership Grant by the PMA, IRUG and EnderTech Inc., Los Angeles, addresses a significant need of Raman users to have access to reliable reference spectra. The participants attending the hands-on training engaged in computer exercises to submit, peer-review and retrieve data. Having mastered these skills, the participants are expected to train a second generation of colleagues, interns, and students to use the database and associated software.

This first-of-its-kind, NCPTT funded workshop was a success. It furthered the public's understanding of Raman spectroscopy in cultural heritage analysis (how it is applied, advantages and limitations) and of the IRUG spectral database as a shared resource for Raman reference data. The professional connections and knowledge gained from the workshop should advance further use of Raman spectroscopy in the field.

## 2. INTRODUCTION

Raman spectroscopy is recognized within the preservation community as a potentially powerful technique for analysis of cultural heritage objects. The use of Raman to aid in the preservation and study of these objects has grown dramatically in recent years. Most major museums own or plan to purchase an instrument, especially for identifying pigments, minerals and corrosion products. However, greater use of Raman has been limited by the lack of training to overcome challenges that are particular to cultural heritage analysis and a lack of suitable reference spectra.

To address the need for information and training, the National Center for Preservation Technology and Training (NCPTT) awarded an $12,000 grant to the Philadelphia Museum of Art (PMA) to support a Raman spectroscopy training workshop for the preservation community. The resulting three day workshop was held at the PMA on September 27-29, 2012.

During the first two days, instructive lectures (open to the general public) were given by sixteen experts on a range of Raman topics that included an historical overview of Raman use in the field; theory and instrumentation; in-situ analysis of photographs, manuscripts and paintings; surface enhanced Raman spectroscopy (SERS); and applications to minerals and pigments, organic colorants and polymers. These topics were discussed in the context of real world examples, along with suggestions for mitigating problems. On the third day, hand-on training was given on how to use the new IRUG Raman spectral database and software that were developed under an Institute of Museum and Library Services (IMLS) National Leadership Grant.

## 3. MATERIALS AND METHODS

Planning and organizational arrangements for the workshop were documented in previous interim reports. In summary, the project team selected the dates for the workshop to maximize attendance, determined the topics for the program, selected instructors, and obtained their commitments. A workshop email address (irugramanworkshop@philamuseum.org) was then setup, followed by a broadcast email announcement sent to universities with art conservation, archeology, historic preservation, and chemistry programs, as well as individuals in the US and abroad. The workshop announcement was posted on the websites of the American Institute of Conservation (conservation-us.org), International Institute of Conservation (iiconservation.org), Conservation Distlist (cool.conservation-us.org), Philadelphia Museum of Art (philamuseum.org) and Infrared and Raman Users Group (irug.org). The workshop was announced at the IRUG10 Biennial Conference in Barcelona (March 2012) and Gordon Conference in West Dover, Vermont (July 2012). Registration and ticketing

was made available through the PMA website and administered by visitor services at the museum. Additional, limited funding was secured from Bruker Optics, Inc. and Five Ash Data Management as travel costs for lecturers had risen substantially after the NCPTT grant was awarded. A training room equipped with computers was provided and trial Raman spectra and software loaded onto the computers for the database training sessions. The workshop schedule of lectures, abstracts, lists of suggested readings and workshop evaluation form were printed and distributed to the attendees on the first day of the workshop.

## 4. RESULTS AND DISCUSSION

The workshop proved very popular and was sold out (102 people strained the capacity of the space reserved for the workshop). A cross-section of scientists, conservators, students, and educators attended. Sixteen experts in the field gave lectures of 45 minutes each with informal discussions during the breaks. Each talk was recorded and the sessions were live streamed to the general public via the internet (www.livestream.com/philamuseum) on September 27 and 28, 2012. The recordings occupy 3.5 GB in MP4 format (H.264 MP4 with ACC audio @ 30 frames per second). 1320 streams were watched during the livestream, with 730 viewings in the US and the remainder in 17 countries abroad. The lecturers' PowerPoint presentations in PDF format may be accessed on the IRUG website (www.irug.org) in the coming weeks for further viewing by the general public.

The workshop schedule of presentations was as follows:

**Day 1: Thursday, September 27**

REGISTRATION & COFFEE, 8:30-9:30
PMA, Main Building, West Entrance, Lenfest Hall

Welcome and opening remarks, 9:30-9:45
Beth Price, Timothy Rub, Andrew Lins (Philadelphia Museum of Art, US)

SESSION 1
Chair: Beth Price, Philadelphia Museum of Art/IRUG Chair Americas

Lecture 1, 9:45-10:30
*Raman reviewed: a short history of the technique in art and artifact studies*
Greg Smith (Indianapolis Museum of Art, US)

Lecture 2, 10:30-11:15
*Basic principles of Raman spectroscopy*

Jennifer Mass (Winterthur Museum, Garden and Library, DE, US)

Lecture 3, 11:15-12:00
*Overview of Raman instrumentation*
Tom Tague (Bruker Optics, Billerica, MA, US)

LUNCH, 12:00-1:30
Free time to visit PMA, Rodin museum, & Barnes Foundation (on own)

SESSION 2
Chair: Suzanne Lomax, National Gallery of Art, Washington, US/IRUG Chair Raman Committee

Lecture 4, 1:30-2:15
*Raman analysis of minerals & pigments*
Richard Newman (Museum of Fine Arts, Boston, US)

Lecture 5, 2:15-3:00
*Raman analysis of museum objects: advantages, limitations, & practical tips*
Lucia Burgio (Victoria and Albert Museum, London, UK)

Lecture 6, 3:00-3:45
*Raman analysis of gems*
Danilo Bersani (University of Parma, IT)

COFFEE BREAK, 3:45-4:30

SESSION 3
Chair: Marcello Picollo, Institute of Applied Physics "Nello Carrara"- National Research Council, Florence, IT/IRUG Chair Asia & Australia

Lecture 7, 4:30-5:15
*Analysis of glass artifacts – applicability of XRF, SEM/EDX, FTIR, and Raman*
Manfred Schreiner, Dubravka Jembrih-Simbuerger (Academy of Fine Arts, Vienna, AT)

Lecture 8, 5:15-5:45
*Introduction to the IRUG Raman spectral database & website software*
Gabriel Richards (Ender Technology Corporation, Los Angeles, US), Beth Price (Philadelphia Museum of Art, US), Boris Pretzel (Victoria and Albert Museum, London, UK), Charles Davis (The Dow Chemical Company, Philadelphia, US), Suzanne Lomax (National Gallery of Art, US), Marcello Picollo (IFAC-CNR), and Andrew Lins (Philadelphia Museum of Art)

Discussion & questions, 5:45-6:00
Marcello Picollo (Institute of Applied Physics "Nello Carrara", National Research Council, Florence, IT)

Closing reminders, 6:00
Beth Price (Philadelphia Museum of Art)

RECEPTION, 6:00-8:00
Granite Hill Museum Restaurant

**Day 2: Friday, September 28**
Presentations

SESSION 1
Chair: Richard Newman, Museum of Fine Arts, Boston/IRUG Board of Directors

Lecture 1, 9:00-9:45
*Synthetic organic pigments: structures & properties*
Suzanne Lomax (National Gallery of Art, Washington, D.C., US)

Lecture 2, 9:45-10:30
*Raman analysis of 19th & 20th century synthetic organic colorants*
Nadim Scherrer (Bern University of the Arts, CH)

Lecture 3, 10:30-11:15
*Surface-enhanced Raman scattering (SERS) of natural & synthetic colorants*
Marco Leona (Metropolitan Museum of Art, New York, US)

Lecture 4, 11:15-12:00
*Synthetic polymers: spectral interpretation*
Bruce Chase (University of Delaware, Newark, DE, US; retired DuPont)

LUNCH, 12:00-1:30
Free time to visit PMA, Rodin museum, & Barnes Foundation (on own)

SESSION 2
Chair: Ken Sutherland, Philadelphia Museum of Art, US/IRUG Review Committee

Lecture 5, 1:30-2:15
*The identification of plastics in modern and contemporary art objects using fiber optics Raman*
Suzan de Groot (Cultural Heritage Agency of the Netherlands, Amsterdam, NL)

Lecture 6, 2:15-3:00
*Raman analysis of paintings, photographs, & works of art on paper*
Silvia Centeno (Metropolitan Museum of Art, New York, US)

COFFEE BREAK, 3:00-3:45

SESSION 3
Chair: Boris Pretzel, Victoria and Albert Museum, London, UK/IRUG Chair Europe & Africa

Lecture 7, 3:45-4:30
*Raman analysis with portable instruments*
Constanza Miliani (University of Perugia, IT)

Lecture 8, 4:30-5:15
*Pick your wavelength: dispersive & FT Raman approaches to the analysis of art materials*
Francesca Casadio (Art Institute of Chicago, US)

Panel discussion, summary & collection of evaluation forms, 5:15-5:45
Boris Pretzel (Victoria and Albert Museum, London, UK)

Closing, 5:45
Beth Price (Philadelphia Museum of Art, US)

SERS Demo, 5:30-7:00
Marco Leona (Metropolitan Museum of Art, NY, US)

On the third day of the workshop, specialized training was conducted on the new IRUG Raman database and software. Interactive exercises were undertaken by participants who learned to submit, peer-review and retrieve Raman data.

Gabriel Richards, CEO, Endertech Inc. was the main instructor. Other trainers included Charles Davis (The Dow Chemical Co.); Andrew Lins, Beth Price, Ken Sutherland (PMA); and Suzanne Lomax (NGA). Participants were Richard Newman (Museum of Fine Arts, Boston, US); Greg Smith (Indianapolis Museum of Art, US); Abigail Teller (New York University); Lauren Klein (University of Florida); Silvia Centeno (Metropolitan Museum of Art, New York, US); Boris Pretzel (Victoria and Albert Museum, London, UK); Constanza Miliani (University of Perugia, IT); Marcello Picollo (Institute of Applied Physics, Nello Carrara, CNR); Suzan de Groot (Cultural Heritage Agency of the Netherlands, Amsterdam, NL); Nadim Scherrer (Bern University of the Arts, CH); Danilo Bersani (University of Parma, IT); and Lucia Burgio (Victoria and Albert Museum, London, UK)

The training followed the schedule listed below:

**Day 3: Saturday, September 29**
Interactive Database Training

COFFEE, 9:00-9:30
PMA, Perelman Building, Computer Training Room

Computer login, etc. 9:30-10:00
Attendees, PMA Information Services

SESSION 1

Lecture 1, 10:00-10:30
*Overview of new IRUG online spectral database, Raman data submission*
Gabriel Richards (Endertech Inc., Los Angeles, US)

Exercise 1, 10:30-11:00
*Navigating the website, creating and managing an IRUG account*
Attendees, trainers

Exercise 2, 11:15-12:00
*Uploading, managing and submitting raw Raman JAMP-DX Spectra*
Attendees, trainers

LUNCH, 12:00-1:30
Working lunch, discussion and questions

SESSION 2

Lecture 1, 1:30-2:15
*Overview of IRUG JCAMP-DX file format, requirements for IRUG Raman reference spectra, data review and retrieval software*
Gabriel Richards (Endertech Inc., Los Angeles, CA, US)

Exercise 1, 2:15-3:00
*Reviewing Raman spectra with review tool, making comments, correcting x/y data, suggesting title lines, and registering votes*
Attendees, trainers

Exercise 2, 2:00-3:30
*Downloading IRUG JCAMP-DX Raman reference spectra*

Attendees, trainers

SESSION 3

BREAK (Stretch), 3:30-3:45

Lecture 1, 3:45-4:15
*Overview of bibliography, glossary, and chemical structures index software*
Gabriel Richards (Endertech Inc., Los Angeles, CA, US)

Exercise 2, 4:15-5:00
*Uploading and reviewing citations, terms and chemical structures*
Attendees, trainers

Closing, 5:00
Beth Price (Philadelphia Museum of Art, US)

The attendee evaluation forms collected at the conclusion of the workshop were overwhelming positive and provided valuable feedback for the IRUG Raman spectral database development team.

## 5. CONCLUSIONS

NCPTT funding enabled the first IRUG Raman Spectroscopy Workshop to be held at the Philadelphia Museum of Art on September 27-29, 2012. The objectives of the workshop were to increase knowledge of Raman spectroscopy in the historic preservation field; introduce a new IRUG Raman spectral database and train participants to submit, review and access reference spectra; and provide a forum for a dialogue about the particular challenges and issues in Raman analysis of cultural heritage materials. With respect to these goals the workshop was a highly successful educational event. Moreover, the IRUG Raman Spectroscopy Workshop should serve as a model for future gatherings intended to promote education and collaboration and to enhance application of Raman spectroscopy in the field.

## 6. ACKNOWLEDGEMENTS

The organizers thank the workshop the lecturers for sharing their knowledge and expertise, participating in the training sessions and sharing their reference spectra with IRUG. Special acknowledgement is given to Dr. Mary Streigel of the NCPTT for her ongoing support of IRUG and its mission to develop quality reference spectra for the historic preservation community. Also recognized are Gabriel Richards, Minh Nguyen, Marc Nimoy, John Yoo, and Anjilla Piazza of Endertech, Inc. for their thoughtful

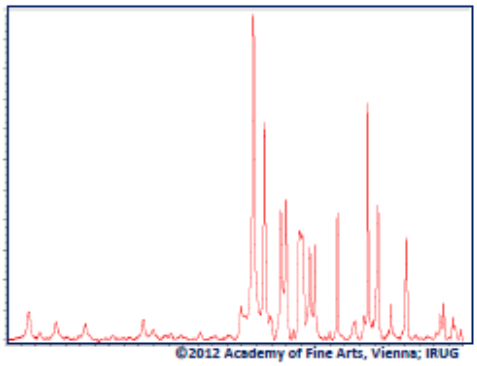
development of the IRUG database and website and workshop training exercises. At the PMA, administrative and technical support was provided by Renee Ward, Conservation Department Records Coordinator; Chris Wasson, Conservation Department Administrator; Andrew Lins, Conservation Department Chair; Ken Sutherland, Conservation Scientist; Erin Soper, Event Planner; Stefan Jewett, Administrative Assistant, Information Services; and Steve Keever, Audio-Visual Production Manager.

## 7. ATTACHMENTS

**Attachment 1 - Workshop Announcement**

# Infrared & Raman Users Group

27-28 September 2012




## *Raman Spectroscopy Workshop for Cultural Heritage Applications*

**Philadelphia Museum of Art**
Ben Franklin Parkway
@ 26th Street
Philadelphia, PA, 19130

**For information and registration go to:**
www.irug.org
**or**
www.philamuseum.org/calendarEvents
**(look up September 27)**

The Infrared and Raman Users Group (IRUG) provides a forum to exchange IR and Raman spectroscopic information for the study of the world's cultural heritage (www.irug.org).

The Group is holding a two-day workshop featuring lectures on the Raman analysis of cultural heritage artifacts and materials. Topics will be the history of Raman use in the field; theory and instrumentation; SERS; analysis of minerals, pigments, dyes, gems, glass, plastics, paint, works of art on paper, cross-sections; and the IRUG Raman Spectral Database

**Registration fee is $75 ($35 students); 31 August deadline**

Speaking will be D. Bersani (U. of Parma), L. Burgio (Victoria & Albert Museum), F. Casadio (Art Institute of Chicago), S. Centeno (Metropolitan Museum of Art), B. Chase (U. of Delaware), S. de Groot (Netherlands Cultural Heritage Institute), M. Leona (Metropolitan Museum of Art), S. Lomax (National Gallery of Art), J. Mass (Winterthur Museum), C. Miliani (U. of Perugia, CNR-ISTM), R. Newman (Museum of Fine Arts, Boston), B. Price (Philadelphia Museum of Art), G. Richards (Endertech), N. Scherrer (Bern University of the Arts), M. Schreiner (Academy of Fine Arts Vienna), G. Smith (Indianapolis Museum of Art), and T. Tague (Bruker).

Attachments 2 and 3, the PDF file and video of presentations, respectively, are being sent on CDs due to file size limit restraints.